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(71) Applicant
STC PLC

(Incorporated in the United Kingdom)

10, Maltravers Street, London, WC2R 3HA, United Kingdom

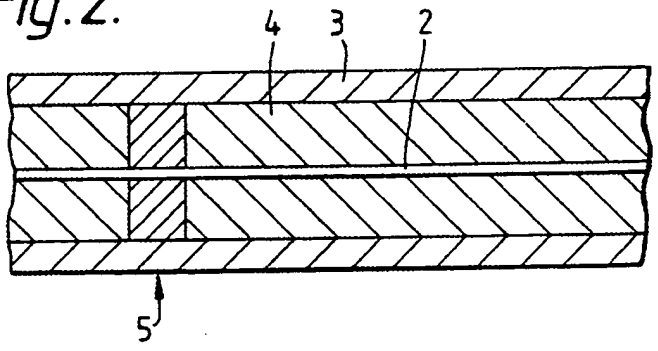
(72) Inventors
Simon Mark Rowland
Mark John Stokell

(74) Agent and/or Address for Service
M C Dennis
STC Patents, West Road, Harlow, Essex, CM20 2SH, United Kingdom

(54) **Optical fibre cable**

(57) A loose tube optical fibre package (1) comprises a tube (3) filled with a material (4) which is such that the application of radiation to the filled tube either intermittently or continuously along the length of the tube (3) results in blocking of the tube at intervals (5) along its length. The filling material may be thermally cross linkable to achieve the blocking and the thermal radiation applied to the tube at intervals, or electromagnetically curable and a "transparent" tube used. If the filling material (4) is blocked along the entire tube length then the tube (32) can later be removed.

Fig.2.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

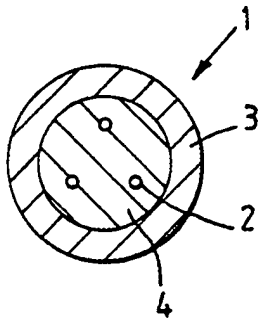
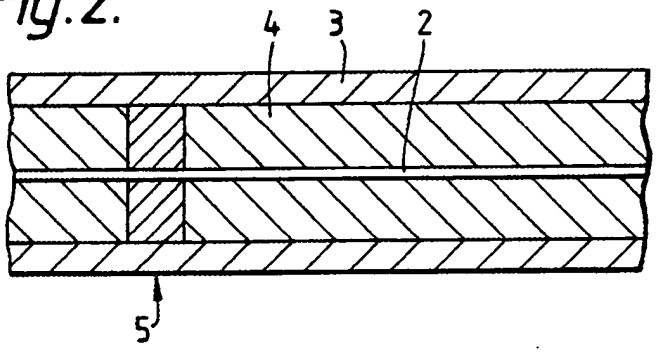


Fig.2.



OPTICAL CABLE.

This invention relates to optical cable and in particular to optical fibre packages, and methods of making them, for use in optical cable.

A typical conventional optical fibre package comprises the so-called "loose tube" configuration. One or more fibres are disposed within a tube which is of larger internal dimensions than the external dimension of the fibre. Longitudinal strains in, and the effects of bending of, cable incorporating such packages are thus prevented from adversely affecting the fibre itself and in particular the strains are borne by the tube. To damp movement of the fibre within the tube, the tube may be filled with viscous material such as polybutenes. When the package is bent the viscous material flows and optical performance is maintained. The viscous material can also act itself as a block to water penetration through the package. Advantageously the tube is blocked at intervals along its length for certain applications, in such a manner that the load (weight) of the fibre is transferred to the tube at the corresponding positions so that movement of the fibre relative to the tube over long distances is prevented. Such applications include use in submarine cables, where during laying the package is substantially vertical and relative movement of the fibre and tube are likely to occur, use when installed in a tower block, and use in aerial cables when long

spans between supporting pylons are involved.

According to one aspect of the present invention there is provided a method of manufacturing an optical fibre package including the steps of providing a loose tube construction by disposing one or more optical fibres within a tube, filling the tube with a filling material, the filling material or tube being such that the application of radiation to the filling material in the tube either intermittently or continuously along the length of the tube results in blocking of the tube at intervals along its length, and applying said radiation.

According to another aspect of the present invention there is provided a method of manufacturing an optical fibre package including the steps of providing a loose tube construction by disposing one or more optical fibres within a tube, filling the tube with a viscous filling material which is cross-linkable by exposure to electromagnetic radiation, the tube being of a material which is transparent to said electromagnetic radiation, and exposing said filling material to said electromagnetic radiation at least at intervals along the length of the tube whereby to cross-link the filling material and achieve blocking of the tube thereat.

According to a further aspect of the present invention there is provided a method of manufacturing an optical fibre package including the steps of providing a loose tube construction by disposing one or more optical fibres within a tube, filling the tube with a filling material, the filling material being such that the application of thermal radiation to the filled tube either intermittently or continuously along the length of the tube results in blocking of the tube at intervals along its length, and applying said thermal radiation.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which

Figure 1 illustrates a cross-section through a loose-tube optical fibre package, and

Figure 2 illustrates a longitudinal section through a fibre package indicating blocking at one point.

The optical fibre package 1 comprises optical fibres 2 loosely housed within a tube 3 which is filled with a filling material 4. In one embodiment the filling material is a viscous gel-like material, such as polyeurethane, which is cross-linkable by electromagnetic radiation, for example UV radiation. The tube 3 is of a material which is transparent at least to the electromagnetic radiation which cross-links the filling material, for example polyethylmethacrylate.

The tube 3 can thus be blocked at intervals along its length by exposing the filling material to the cross-linking radiation at predetermined positions along the length of the package. This can be achieved on a conventional loose tube manufacturing line and subsequently, or by the insertion of a suitable radiation source at an appropriate position in the line, switching the radiation source on for appropriate periodic time intervals (pulsing). The effect of this is to cross-link the filling material as at point 5 (Fig. 2) and thereby convert the loose tube to a tight tube construction at point 5. The load (weight) of the fibre 2 and filling 4 will thus be transferred to the tube 3 at points such as 5. As a result relative movement between fibre and tube over long distances will be prevented. The distance between points such as 5 is typically a few metres.

If the tube material is intermittently transparent, along its length, to the cross-linking radiation, then intermittent blocking could be achieved with a continuous rather than pulsed radiation source.

If desired the filling material could be cross-linked along the entire tube length or for portions thereof longer than that required for blocking at intervals simply be suitable exposure to the cross-linking radiation, thus producing a wholly or partially tight jacket construction. In the case of production of a wholly tight jacket, the tube 3 is needed no longer after cross-linking and can then be removed. In this way a smaller more flexible package can be achieved.

In another embodiment the filling material is a viscous material which is cross-linked by thermal radiation and the tube material is conventional, for example polyeurethane. The tube 3 can thus be blocked at intervals along its length by suitably heating the tube and the filling material at intervals (predetermined positions) along its length. This can be achieved using a conventional loose tube manufacturing line and subsequently, or by the insertion of a suitable thermal source at an appropriate position in the line, switching the thermal source on for appropriate periodic time intervals. The effect of this is to cross-link the filling material as at point 5 (Fig. 2) and thereby convert the loose tube to a tight tube at point 5 and bind the cross-linked filling material to the tube so that load (weight) of the fibre and filler is transferred to the tube at positions such as 5. As a result relative movement between fibre and tube over long distances when disposed vertically will be prevented. The distance between point 5 is typically several metres.

Cross-linking at intervals may alternatively be achieved using a two-part filling material which is curable thermally but only providing (injecting) the second part at those positions where cross-linking (blocking) is required. In this case the whole length of the tube will be suitably heated but cross-linking will only occur at positions where the second part was injected. The other (first) part of the two-part filling material will have the same or similar viscous properties to the conventional fillers. A typical filling material comprises a two part silicone polymer. As with the previously described embodiment the tube material and the remainder of the loose tube manufacture process may be conventional.

A two-part filling material can also be used with an electromagnetic (optical) curing radiation. In this case the tube will need to be transparent to the curing radiation. The second part of the filling material will only be injected where the blocking is required. The electromagnetic radiation will be continuous rather than intermittent (pulsed) as describe above.

CLAIMS

1. A method of manufacturing an optical fibre package including the steps of providing a loose tube construction by disposing one or more optical fibres within a tube, filling the tube with a filling material, the filling material or tube being such that the application of radiation to the filling material in the tube either intermittently or continuously along the length of the tube results in blocking of the tube at intervals along its length, and applying said radiation.

2. A method of manufacturing an optical fibre package including the steps of providing a loose tube construction by disposing one or more optical fibres within a tube, filling the tube with a viscous filling material which is cross-linkable by exposure to electromagnetic radiation, the tube being of a material which is transparent to said electromagnetic radiation, and exposing said filling material to said electromagnetic radiation at least at intervals along the length of the tube whereby to cross-link the filling material and achieve blocking of the tube thereat.

3. A method as claimed in claim 2 wherein the filling material is cross-linked along the entire length of the tube and including the step of subsequently removing the tube therefrom.

4. A method as claimed in claim 2 wherein the filling material is a polyurethane the tube material is PMMA and the electromagnetic radiation is U.V.

5. A method as claimed in claim 2, wherein the tube is intermittently transparent to said electromagnetic radiation along its length and the electromagnetic radiation is applied continuously, the filling material being cross-linked at positions corresponding to said transparent parts of the tube.

6. A method of manufacturing an optical fibre package including the steps of providing a loose tube construction by disposing one or more optical fibres

within a tube, filling the tube with a filling material, the filling material being such that the application of thermal radiation to the filled tube either intermittently or continuously along the length of the tube results in blocking of the tube at intervals along its length, and applying said thermal radiation.

7. A method as claimed in claim 6 wherein the filling material is thermally cross-linkable and the thermal radiation is applied intermittently.

8. A method as claimed in claim 6 wherein the filling material consists of a two-part thermal curing system, wherein one part of the curing system is injected continuously into said tube during the filling process and the other part is injected intermittently into said tube during the filling process, and wherein the application of thermal radiation continuously along the length of the tube results in curing of the filling material at said intervals along the tube length.

9. A method as claimed in claim 7 wherein the filling material is polyurethane.

10. A method as claimed in claim 8 wherein the filling material is a two part silicone polymer.

11. A method as claimed in claim 1 wherein the filling material consists of a two-part curing system which is curable by electromagnetic radiation, wherein one part of the curing system is injected continuously into said tube during the filling process and the other part is injected intermittently into said tube during the filling process, and wherein the application of said electromagnetic radiation continuously along the length of the tube results in curing of the filling material at said intervals along the tube length.

12. A method of manufacturing an optical fibre package substantially as herein described with reference to the accompanying drawings.

13. An optical fibre package manufactured by a method according to any one of the preceding claims.

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